SCIENCE

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THE ISODYNAMIC REPLACEMENT OF NUTRIENTS.

THIS term was introduced into physiology by Rubner about 1885 as a concise expression of the results of his experiments upon the relative values in nutrition of the three great classes of nutrients, the proteids, carbohydrates and fats.

It was already well established by the labors of previous investigators, notably of Pettenkofer and Voit in Munich, that, aside from a certain rather small amount of proteids which is indispensable, the animal body possesses a remarkable degree of flexibility as regards the nature of the material which it can use to support its vital processes. Aside from the necessary minimum of proteids, the metabolic activities of the body may be supported, now at the expense of the stored body fat, now by the body proteids, and again by the proteids, the fats or the carbohydrates of the food. Whatever may be true economically, physiologically the welfare of the mature animal is not conditioned upon any fixed relation between the classes of nutrients in its food supply, apart from the minimum requirement for proteids. The problem which Rubner proposed to himself was to determine the relative quantities of the several nutrients which were equivalent to each other in the vital processes of the ani-

mal—in other words, to substitute quantitative for qualitative knowledge.

It is well known that a fasting animal consumes the tissues of its own body to sustain its vital activities. Thus in one of Rubner's experiments a fasting dog oxidized per day the equivalent of 20.51 grams of dry muscular tissue (lean meat) and in addition 75.92 grams of his fat. He was then given 740 grams per day of fresh lean meat. On this ration he was found to oxidize the equivalent of 133.89 grams of dry muscular tissue, but only 30.72 grams of the fat of his body. In other words, the oxidation of 113.38 grams more of muscular tissue derived from the lean meat eaten diminished the draft upon the body-fat of the dog by 45.20 grams. Plainly, these two quantities were equivalent, or, after making some slight corrections, 243 parts of dry lean meat were equivalent to 100 parts of fat. A number of similar experiments were made with extracted meat and with various carbohydrates, while in a few cases fat and carbohydrates were interchanged in the food, and a series of ratios like the above were obtained, varying with the material experimented on.

All these results, however, are purely empirical. They explain nothing. The fact, however, that the nutrients can mutually replace each other through so wide a range, and the other fact that the animal body is essentially a transformer of the potential energy of the food into the kinetic energy of heat and motion, suggest that the nutrients replace each other because they all serve as sources of energy to the organism. Acting on this hint, Rubner proceeded to determine the amounts of energy which the several nutrients could liberate in the body. This, by a well-known principle of thermochemistry, is measured by the difference between the potential energy of the substance and that of the products of its decomposition. The potential energy of the nutrients is measured, for this purpose, by their heats of combustion. In the case of the carbohydrates and fats, the products of their decomposition in the body are (in the carnivora) substantially carbon dioxide and water, which contain no measurable amount of potential energy. With the proteids the case is different. Here we have various partially oxidized compounds contained in feces and urine, the potential energy of which Rubner summarily determined by determining the heats of combustion of the dried excreta. In this way he was able to determine how much energy a given amount of lean meat or fat or starch was capable of liberating in the animal organism, and this amount he called its physiological heat value.

When, now, he came to compare the amounts of the several nutrients from which equal quantities of energy could be liberated in the body with the amounts which were found to replace each other in actual feeding experiments, he obtained a most remarkable correspondence. The first column of the table shows the amounts of the several substances required to liberate the same amount of energy as 100 grams of fat, while the second column shows the amounts which were found to replace 100 grams of fat in the nutrition of the animal.

	Yielding Energy Equal to 100 Grams Fat.	Replacing 100 Grams Fat in the Body.
Lean meat.....	235 grams.	243 grams.
Extracted meat..	213 "	225 "
Cane sugar.....	235 "	234 "
Starch.....	229 "	232 "
Grape sugar.....	255 "	256 "

The teaching of these figures seems perfectly clear. The nutrients are the fuel of the body—its supply of energy—and they replace each other just in proportion to the energy they are capable of liberating.

This law Rubner called the law of isodynamic replacement.*

This law was based upon the conception that the same laws of energetics which control the chemical changes of so-called dead matter also rule the far more complex ones which occur in the living organism, and that the energy which the animal imparts to its surroundings is simply the transformed energy of its food, or, in other words, that the law of the conservation of energy applies to the animal body. Later experiments by Rubner, directed more specifically to this broader aspect of the question, went far to demonstrate the truth of this conclusion, while the later investigations of Laulanié and especially the very extensive ones of Atwater and his associates, Rosa and Benedict, seem to have placed it beyond question.

It is practically to Rubner, then, whatever suggestions may have been made previously, that we owe the effective introduction into physiology of the conception that the relative values of the several nutrients, except as to the special functions of the proteids, are measured by their physiological heat values, or 'fuel values' as they are called by Atwater. This conception has proved to be a fruitful one and has profoundly influenced the study of animal nutrition.

As is so often the case, however, further study has revealed the necessity for modifications and has shown that in its first form the law of isodynamic replacement was, after all, but a partial statement of the truth.

Rubner's experiments were made with animals in a state of rest and with amounts of food insufficient to cause any storing up of flesh or fat in the body. Under these conditions all the energy set free by the burning of food or tissue to support the vital activities, whatever forms it may temporarily take, finally appears as heat which is imparted to the surroundings of the animal. The law of isodynamic replacement, now, implies that the heat production of such an animal is unaffected, at least below the maintenance requirement, by changes in the amount and kind of food consumed. Thus, if the animal oxidizes while fasting 100 grams of body fat, and if it be then given an amount of starch equivalent in energy to 100 grams of fat, viz., 229 grams, this starch should be burned in place of the fat. That is, there will be simply a substitution of one kind of fuel for another, but no increase in the total heat production.

It is, however, an observation as old as the time of Lavoisier that the consumption of food tends to *increase* the heat production, and the fact has been fully established by a host of subsequent investigators. The taking of food calls into activity a whole set of organs that were previously in a state of relative inactivity. The mastication and swallowing of the food and its passage through the alimentary canal involve a not inconsiderable amount of muscular work. In addition to this the various secreting glands are called into action to supply the digestive fluids, while the resulting chemical and fermentative changes in the food itself add their quota to the heat arising from the muscular and glandular activity. This heat, of course, may aid in keeping the animal warm, but otherwise, so far as we know, it is of no direct use to the organism, while often the body has already a superabundant supply and is really engaged in getting rid of heat.

It appears, then, that the mere supplying of more energy to the body in the shape of food sets up a demand for more energy to

* Conclusions very similar, although not based upon their own investigations, had been previously announced by v. Hoesslin and by Danilewsky.

digest and assimilate this food. The case is analogous to that of a steam-boiler which is fired by means of a mechanical stoker driven by steam from the same boiler. Each pound of coal fed into the fire-box is capable of evolving a certain amount of heat, and that heat is capable of producing a certain quantity of steam. A definite fraction of the latter, however, is required to introduce the next pound of coal into the furnace and, therefore, is not available for driving the main engine.

It is plain, however, that this view of the matter is inconsistent with the law of isodynamic replacement as above stated. If the consumption of food causes an increased expenditure of energy by the body, then we do not have simply a replacement of one kind of fuel by another, such as the law of isodynamic replacement predicates, but in addition an actual stimulation of the combustion. To recur to the previous illustration, to prevent the oxidation of 100 grams of fat in the fasting animal would require not only the 229 grams of starch equivalent in energy to the 100 grams of fat, but also enough more to supply the energy required to digest and assimilate the starch. As a matter of fact, Rubner actually did find that slightly more than the theoretical amount of starch was required, viz., 232 grams instead of 229 grams, and the same was true with the other materials experimented on with the exception of cane sugar.

Such substances as meat, starch and sugar, however, are comparatively easy of digestion, and the latter two, at least, do not call for any large expenditure of energy, so that it is difficult to decide whether the small differences in Rubner's figures are significant or not. A material requiring more digestive work would obviously furnish a more decisive test. Such materials are offered in the food of herbivora, particularly in the so-called 'coarse fodders' (hay, straw, etc.), and the recent completion at the Pennsylvania Experiment Station of a respiration-calorimeter* for experiments with cattle afforded an opportunity to test the question with these animals.

The feed used was a rather coarse timothy hay. The steer was fed a very light ration of the hay, together with a little linseed meal, the whole 'basal ration' being much less than was required to support the animal. On this basal ration the steer produced 9,229 calories of heat in 24 hours. During the same time it was shown that he oxidized 49.2 grams of the proteids and 259 grams of the fat of his body, equivalent to 2,578 calories of energy.

Then 1.2 kilograms of the hay were added to the basal ration. It was shown that, after deducting the various unoxidized wastes, this hay represented a fuel value of 2,840 calories; that is, oxidized to the fullest extent to which the organism was capable of carrying it, could liberate that amount of energy. If, now, the law of isodynamic replacement is applicable to this case, that is, if it was simply a question of substituting one kind of fuel for another, the digestible matter of the hay, yielding 2,840 calories of energy, should have prevented the oxidation of an equivalent amount of body tissue. As a matter of fact it fell far short of doing this. On the increased ration, the daily loss by the body of the animal was 7.2 grams of proteids and 80.6 grams of fat, equivalent to 791 calories of energy, while the heat production in 24 hours was 10,249 calories as compared with 9,229 calories on the smaller

* The apparatus is modeled after that of Atwater and Rosa. It was constructed and is being operated in cooperation by the Bureau of Animal Industry of the U. S. Department of Agriculture and The Pennsylvania State College Agricultural Experiment Station.

ration. While the addition of the hay considerably diminished the loss of tissue by the animal, it at the same time caused an increase of over ten per cent. in the heat production; that is, a portion of its fuel value, instead of taking the place of energy previously derived from the oxidation of tissue, was required for the various processes incident to the digestion and assimilation of the hay and ultimately appeared as heat. The loss of tissue was diminished by 1,787 calories by the addition of hay having a fuel value of 2,840 calories. In round numbers, then, only 63 per cent. of the fuel value of the hay was used by the body in place of the energy previously derived from the oxidation of tissue, instead of 100 per cent. as required by the law of isodynamic replacement, while the remaining 37 per cent. became practically an excretum.

The results of a single experiment are, of course, to be accepted with reserve. At the same time, however, the discrepancy is far too great to be accounted for by any possible errors in the determinations of the amounts of energy involved, while there was not the slightest indication of anything abnormal in the state of the animal or in the conditions of the experiment. We are forced to the conclusion that in this case at least the digestible matter of the food was not isodynamic with body substance, or in other words, that its fuel value was not, as has been ordinarily assumed, a measure of its value for maintenance.

It may perhaps be objected that the mixture of ill-known materials digested from hay is a very different thing from the nearly pure nutrients employed in Rubner's experiments, and that it very naturally has a lower nutritive value. Such an objection, however, while perfectly true, would be irrelevant. It is precisely because these materials require the expenditure upon them of a considerable amount of energy, mechanical and chemical, to fit them for the metabolism of the body, that there is this large loss. The difference is one of degree rather than of kind. The cellulose of hay, for example, undergoes an extensive fermentation in the first stomach of ruminants, yielding methane, carbon dioxide and various organic acids. This fermentation is accompanied by an evolution of heat which becomes largely or wholly waste, since the animal body appears to be unable to convert heat into other forms of energy. Undoubtedly this escape of energy during fermentation constitutes a part, and not improbably a large part, of the 37 per cent. of loss observed with the steer. When starch is fed to a dog, it is converted into dextrins, maltose and isomaltose and finally into dextrose by the action of the various digestive ferments. In this process there is likewise a loss of energy, very much smaller it is true than in the case of the cellulose, but just as really a loss. Similarly, the mechanical work of digestion is far less with pure nutrients than with hay, but is by no means equal to zero.

It was noted above that Rubner's own equivalents show that slightly more than the theoretical amounts of nutrients were required to replace body tissue. The writer recently made a careful compilation of all accessible results bearing on this question. After rejecting two experiments by Rubner with cane sugar, in which values considerably over 100 per cent. were obtained, and which Rubner himself considers of doubtful value, all the other trials give values less than 100 per cent. except one experiment on fat and one early one by Pettenkofer and Voit which gives the impossible value of 115 per cent. The deficit is often small and in some cases may not exceed the probable experimental error, but the general tendency appears signifi-

cant, especially when taken in connection with the very marked result of the experiment on hay.

Quite recently Rubner has published in book form * an elaborate discussion of this question, including the results of later experiments on dogs, in which amounts of fats, carbohydrates or proteids considerably in excess of those required for the simple maintenance of the body were fed. Under these conditions he finds that all these nutrients, but especially the proteids, may cause a marked increase in the heat production of the animal. In other words, he shows that what appears to be true of ruminants below the maintenance requirement is equally true of carnivora when the amount of food consumed is relatively large.

It would appear, then, that the law of isodynamic replacement as it has been commonly taught must be modified. That law, as stated above, is that the 'fuel values,' or 'physiological heat values,' of the several nutrients represent their relative worth to the animal body except for the peculiar constructive function of the proteids. In other words, the food is regarded as the fuel of the vital furnace. The fundamental error of this view lies in the fact that it more or less consciously assumes that the production of heat in the body is an end in itself. The truth appears to be that it is, in a physiological sense, an incident. The energy of the food is needed for the performance of the vital processes. During these processes it undergoes various transformations, but finally the larger part, or in the resting animal all, is degraded into heat, which incidentally serves to maintain the temperature of the body, and, as it would seem, is amply sufficient for this purpose under a wide range of conditions.

Such being the case, the value of a food is not measured by the amount of heat which it can liberate in the body, but by the extent to which its energy is available for the vital processes. When, as in the case of the hay, 37 per cent. of the fuel value is consumed in separating the valuable from the worthless portions and in transporting the former to the point of use, the final net advantage to the animal is represented by the remaining 63 per cent. If the gross receipts of a business are one hundred dollars per day and the running expenses thirty-seven dollars, it is plain that the net receipts are only sixty-three dollars, no matter how necessary the expenses may be.

Of course this has a limit. As the temperature to which an animal is exposed falls, and the consequent draft on the body for heat increases, a point will be reached at which the production of heat is just equal to the demand. Below this point, cold seems actually to stimulate in some way the heat production of the animal. Under these circumstances Rubner appears to have demonstrated that the heat produced by the processes of digestion and assimilation may be of use indirectly by obviating the necessity of burning more tissue to supply the necessary heat, and that consequently at relatively low temperatures the fuel value of the food may be the measure of its worth, that is, that isodynamic replacement may occur. Above a certain temperature and a certain amount of food, however, varying with the kind of animal and with the nature of the food, the law ceases to hold and the specific differences in the availability of nutrients or foods reveal themselves.

But while it thus appears that the law of isodynamic replacement is of but limited application, this should not blind us to the vast importance of Rubner's earlier work. It established a new point of view and

* 'Die Gesetze des Energieverbrauchs bei der Ernährung.'

gave a unity to our conceptions of the function of nutrition which they previously lacked. The law of isodynamic replacement is but a single phase of the question. The fundamental idea is that the vital activities are manifestations of the same energy which is seen in operation throughout the universe, are subject to the same laws and may be studied by similar methods. It is his firm grasp of this broad conception, and not the exact scope or accuracy of a single expression of it, which has given Rubner's investigations their preeminent value.

H. P. ARMSBY.

*METHODS OF METEOROLOGICAL INVESTIGATION.**

IN opening the proceedings of the subsection devoted to cosmical physics, which we may take to be the application of the methods and results of mathematics and physics to problems suggested by observations of the earth, the air or the sky, I desire permission to call your attention to some points of general interest in connection with that department which deals with the air. My justification for doing so is that this is the first occasion upon which a position in any way similar to that which I am now called upon to fill has been occupied by one whose primary obligations are meteorological. That honor I may with confidence attribute to the desire of the council of the association to recognize the subject so admirably represented by the distinguished men of science who have come across the seas to deliberate upon those meteorological questions which are the common concern of all nations, and whom we are specially glad to welcome as members of this subsection. Their presence and their scientific work are proof, if proof is required, that meteorologists can not regard meteorological problems as dissociable from Section A; that the prosecution of meteorological research is by the study of the kinematics, the mechanics, the physics or the mathematics of the data compiled by laborious observation of the earth's atmosphere.

But this is not the first occasion upon which the address from the chair of the subsection has been devoted to meteorology. Many of you will recollect the trenchant manner in which a university professor, himself a meteorologist, an astronomer, a physicist and a mathematician, dealt candidly with the present position of meteorology. After that address I am conscious that I have no claim to be called a meteorologist according to the scientific standard of Section A. Professor Schuster has explained—and I can not deny it—that the responsible duty of an office from which I can not dissociate myself is signing weather reports; and I could wish that the duty of making the next address had been intrusted to one of my colleagues from across the sea. But as Professor Schuster has set forth the aspect of official meteorology as seen from the academic standpoint with a frankness and candor which I think worthy of imitation, I shall endeavor to put before you the aspect which the relation between meteorology and academic science wears from the point of view of an official meteorologist whose experience is not long enough to have hardened into that most comfortable of all states of mind, a pessimistic contentment.

Meteorology occupies a peculiar position in this country. From the point of view of mathematics and physics, the problems which the subject presents are not devoid of interest, nor are they free from that difficulty which should stimulate scientific effort in academic minds. They afford a

* Address before the Subsection of Astronomy and Meteorology, British Association for the Advancement of Science. Opening address by the chairman, Southport meeting, 1903.

most ample field for the display of trained intellect, and even of genius, in devising and applying theoretical and experimental methods. And can we say that the work is unimportant? Look where you will over the countries which the British Association may be supposed to represent, either directly or indirectly, and say where a more satisfactory knowledge of the laws governing the weather would be unimportant from any point of view. Will you take the British Isles on the eastern shores of the Atlantic, the great meteorological laboratory of the world, with the far-reaching interests of their carrying trade? or India, where the phenomena of the monsoon show most conspicuously the effects of the irregular distribution of land, the second great meteorological cause, and where recurring famines still overstrain the resources of administration? Take the Australasian colonies and the Cape, which, with the Argentine Republic, where Mr. Davis is developing so admirably the methods of the Weather Bureau, constitute the only land projections into the great southern ocean, the region of 'planetary meteorology,' or Australia, with its periods of paralyzing drought; the Cape, where the adjustment of crops to climate is a question of the hour. Or take Canada, which owns at the same time a granary of enormous dimensions and a large portion of the Arctic Circle. Or take the scattered islets of the Atlantic and Pacific or the shipping that goes wherever ships can go. The merest glance will show that we stand to gain more by scientific knowledge, and lose more by unscientific ignorance of the weather, than any other country. The annual loss on account of the weather would work out at no inconsiderable sum per head of the population, and the merest fraction of success in the prevention of what science must regard as preventable loss would compensate for half a century of expenditure on meteorological offices. Or take a less selfish view and consider for a moment our responsibilities to the general community of nations, the advantages we possess as occupying the most important posts of observation. If the meteorology of the world were placed, as perhaps it ought to be, in the hands of an international commission, it can be no exaggeration to say that a considerable majority of the selected sites for stations of observation would be on British soil or British ships. We can not help being the most important agency for promoting or for obstructing the extension of meteorological science. I say this bluntly and perhaps crudely because I feel sure that ideas not dissimilar from these must occasionally suggest themselves to every meteorologist, British or foreign; and if they are to be expressed—and I think you will agree with me that they ought to be—a British meteorologist ought to take the responsibility of expressing them.

And how does our academic organization help us in this matter of more than parochial or even national importance? There was a time when meteorology was a recognized member of the large physical family and shared the paternal affection of all professors of physics; but when the poor nestling began to grow up and develop some individuality electricity developed simultaneously with the speed of a young cuckoo. The professors of physics soon recognized that the nest was not large enough for both, and with a unanimity which is the more remarkable because in some of these academic circles utilitarianism is not a condition of existence, and pure science, not market value, might be the dominant consideration—with singular unanimity the science which bears in its left hand, if not in its right, sources of wealth beyond the

dreams of avarice was recognized as a veritable Isaac, and the science wherein the fruits of discovery must be free for all the world, and in which there is not even the most distant prospect of making a fortune—that science was ejected as an Ishmael. Electrical engineering has an abundance of academic representatives; brewing has its professorship and its corps of students, but the specialized physics of the atmosphere has ceased to share the academic hospitality. So far as I know, the British universities are unanimous in dissembling their love for meteorology as a science, and if they do not actually kick it down stairs they are at least content that it has no encouragement to go up. In none is there a professorship, a lectureship or even a scholarship to help to form the nucleus of that corps of students which may be regarded as the primary condition of scientific development.

Having cut the knot of their difficulties in this very human but not very humane method, the universities are, I think, disposed to adopt a method of justification which is not unusual in such cases; indications are not wanting which disclose an opinion that meteorology is, after all, not a science. There are, I am aware, some notable exceptions; but do I exaggerate if I say that when university professors are kind enough to take an interest in the labors of meteorologists, who are doing their best amid many discouragements, it is generally to point out that their work is on the wrong lines; that they had better give it up and do something else? And the interest which the universities display in a general way is a good-humored jest about the futility of weather prophecy, and the kindly suggestion that the improvement in the prediction of the next twenty-four hours' weather is a natural limit to the orbit of an Ishmaelite's ambition.

In these circumstances such an address as Professor Schuster's is very welcome; it recognizes at least a scientific brotherhood and points to the responsibility for a scientific standard; it even displays some of the characteristics of the Good Samaritan, for it offers his own beast on which to ride, though it recommends the unfortunate traveler to dispose of what little clothing the stripping has left to provide the two pence for the host.

It is quite possible that the unformulated opinion of the vast majority of people in this country, who are only too familiar with the meteorological vagaries of the British Isles, is that the weather does just as it pleases; that any day of the year may give you an August storm or a January summer's day; that there are no laws to be discovered, and that the further prosecution of so unsatisfactory a study is not worth the time and money already spent upon it. They forget that there are countries where, to judge by their languages, the weather has so nearly the regularity of 'old time' that one word is sufficient to do duty for both ideas. They forget that our interests extend to many climates, and that the characteristics of the eastern shores of the North Atlantic are not appropriate to, say, western tropical Africa. That may be a sufficient explanation of the attitude of the man in the street, but as regards the British universities dare I offer the difficulty of the subject as a reason for any want of encouragement? Or shall I say that the general ignorance on the part of the public of the scientific aspirations and aims of meteorologists and of the results already obtained is a reason for the universities to keep silence on the subject? With all respect I may say that the aspect which the matter presents to official meteorologists is that the universities are some-

what oblivious of their responsibilities and their opportunities.

I have no doubt that it will at once be said that meteorology is supported by government funds, and that alma mater must keep her maternal affection and her exiguous income for subjects that do not enjoy state support. I do not wish just now to discuss the complexities of alma mater's housekeeping. I know she does not adopt the same attitude with regard to astronomy, physics, geology, mineralogy, zoology or botany, but let that pass. From the point of view of the advancement of science I should like to protest against the idea that the care of certain branches of science by the state and by the universities can be regarded as alternative. The advancement of science demands the cooperation of both in their appropriate ways. As regards meteorology, in my experience, which I acknowledge is limited, the general attitude towards the department seems to be dictated by the consideration that it must be left severely alone in order to avoid the vicious precedent of doing what is, or perhaps what is thought to be, government work without getting government pay, and the result is an almost monastic isolation.

There is too much isolation of scientific agencies in this country. You have recently established a national physical laboratory the breath of whose life is its association with the working world of physics and engineering, and you have put it—where? At Cambridge, or anywhere else where young physicists and engineers are being trained? No; but in the peaceful seclusion of a palace in the country, almost equidistant from Cambridge, Oxford, London and everywhere else. You have established a meteorological office, and you have put it in the academic seclusion of Victoria Street. What monastic isolation is good for I do not know. I am perfectly certain it is not good for the scientific progress of meteorology. How can one hope for effective scientific development without some intimate association with the institutions of the country which stand for intellectual development and the progress of science?

I could imagine an organization which by association of the universities with a central office would enable this country, with its colonies and dependencies, to build up a system of meteorological investigation worthy of its unexampled opportunities. But the cooperation must be real and not one-sided. Meteorology, which depends upon the combination of observations of various kinds from all parts of the world, must be international, and a government department in some form or other is indispensable. No university could do the work. But whatever form government service takes, it will always have some of those characteristics which, from the point of view of research, may be called bondage. On the other hand, research, to be productive, must be free with an academic freedom, free to succeed or fail, free to be remunerative or unremunerative, without regard to government audits or House of Commons control. Research looks to the judgment of posterity with a faith which is not unworthy of the churches, and which is not among those excellent moral qualities embodied in the controller and auditor-general. *Die academische Freiheit* is not the characteristic of a government department. The opportunity which gave to the world the 'Philosophiæ Naturalis Principia' was not due to the state subvention of the deputy mastership of the mint, but to the modest provision of a professorship by one Henry Lucas, of whose pious benefaction Cambridge has made such wonderful use in her Lucasian professors.

The future of meteorology lies, I believe,

in the association of the universities with a central department. I could imagine that Liverpool or Glasgow might take a special interest in the meteorology of the sea; they might even find the means of maintaining a floating observatory; and when I say that we know practically nothing of the distribution of rainfall over the sea, and we want to know everything about the air above the sea, you will agree with me that there is room for such an enterprise. Edinburgh might, from its association with Ben Nevis, be desirous of developing the investigation of the upper air over our land; in Cambridge might be found the author of a book on the principles of atmospheric physics, worthy of its Latin predecessor; and for London I can assign no limited possibilities.

If such an association were established I should not need to reply to Professor Schuster's suggestion for the suppression of observations. The real requirement of the time is not fewer observations, but more men and women to interpret them. I have no doubt that the first expression of such an organization would be one of recognition and acknowledgment of the patience, the care, the skill and the public spirit—all of them sound scientific characteristics—which furnish at their own expense those multitudes of observations. The accumulated readings appal by their volume, it is true, but they are, and must be, the foundation upon which the scientific structure will be built.

So far as this country is concerned, when one puts what is in comparison with what might be it must always be acknowledged that the tendency to pessimistic complaisance is very strong. Yet I ought not to allow the reflections to which my predecessor's address naturally gave rise to be too depressing. I should remember that, as Dr. Hellmann said some years ago, meteorology has no frontiers, and each step in its progress is the result of efforts of various kinds in many countries, our own not excluded. In the presence of our guests to-day, some of whom know by practical experience the advantages of the association of academic liberty with official routine, remembering the recent conspicuous successes in the investigation of the upper air in France, Germany, Austria and the United States, and the prospect of fruitful cooperation of meteorology with other branches of cosmical physics, I may well recall the words of Clough:

> Say not, the struggle nought availeth * * *
> And as things have been, things remain.
>
> If hopes were dupes, fears may be liars;
> It may be, in yon smoke concealed
> Your comrades chase e'en now the fliers,
> And, but for you, possess the field.
>
> For while the tired waves, vainly breaking,
> Seem here no painful inch to gain,
> Far back, through creeks and inlets making,
> Comes silent, flooding in, the main.
>
> And not by eastern windows only,
> When daylight comes, comes in the light;
> In front, the sun climbs slow, how slowly,
> But westward, look, the land is bright.

Official meteorologists are not wanting in scientific ambitions and achievements. It is true that Professor Hann, whose presence here would have been so cordially welcomed, left the public service of Austria to continue his services to the world of science by the compilation of his great handbook, and Snellen is leaving the direction of the weather service of the Netherlands for the more exclusively scientific work of directing an observatory of terrestrial physics; but I am reminded by the presence of Professor Mascart of those services to meteorological optics and terrestrial magnetism that make his place as president of the international committee so natural and fitting; and of the solid

work of Angot on the diurnal variation of the barometer and the reduction of barometric observations for height that form conspicuous features among the many valuable memoirs of the Central Bureau of Paris.

Of the monumental work of Hildebrandsson in association with Teisserenc de Bort on clouds, which culminated quite recently in a most important addition to the pure kinematics of the atmosphere, I hope the authors will themselves speak. Professor Willis Moore's presence recalls the advances which Bigelow has made in the kinematics and mechanics of the atmosphere under the auspices of Professor Moore's office, and reminds us of the debt of gratitude which the English-speaking world owes to Professor Cleveland Abbe of the same office, for his treatment of the literature of atmospheric mechanics.

If General Rykatcheff had only the magnificent climatological 'Atlas of the Russian Empire' to his credit he might well rest satisfied. Professor Mohn's contributions to the mechanics of the atmosphere are examples of Norwegian enterprise in the difficult problems of meteorology, while Dr. Paulsen maintains for us the right of meteorologists to share in the results of the newest discoveries in physics. Davis's enterprise in the far south does much to bring the southern hemisphere within our reach, while Chaves places the meteorology of the mid-Atlantic at the service of the scientific world. Need I say anything of Billwiller's work upon the special effect of mountains upon meteorological conditions, or of the immense services of the joint editors of the *Meteorologische Zeitschrift*, Professor Pernter, of Vienna, and Dr. Hellmann, of Berlin; of Palazzo's contributions to terrestrial magnetism. The mention of Eliot's Indian work, or of Russell's organization of Australian meteorology, will be sufficient to show that the dependencies and colonies are prepared to take a share in scientific enterprise. And if I wished to reassure myself that even the official meteorology of this country is not without its scientific ambitions and achievements, I would refer not only to Scott's many services to science, but also to Strachey's papers on Indian and British meteorology and to the official contributions to marine meteorology.

There is another name, well known in the annals of the British Association, that will forever retain an honored place among the pioneers of meteorological enterprise—that of James Glaisher, the intrepid explorer of the upper air, the Nestor of meteorologists, who has passed away since the last meeting of the association.

I should like especially to mention Professor Hergesell's achievements in the organization of the international investigation of the upper air by balloons and kites, because it is one of the departments which offer a most promising field for the future, and in which we in this country have a good many arrears to make up. I hope Professor Hergesell will later on give us some account of the present position of that investigation, and I am glad that Mr. Rotch, to whose enterprise the development of what I may call the scientific kite industry is largely due, is present to take part in the discussion.

Yet with all these achievements it must be confessed that the progress made with the problems of general or dynamical meteorology in the last thirty years has been disappointing. When we compare the position of the subject with that of other branches of physics it must be allowed that it still lacks what astronomy found in Newton, sound in Newton and Chladni, light in Young and Fresnel, heat in Joule, Kelvin, Clausius and Helmholtz, and electricity in

Faraday and Maxwell. Above all, it lacks its Kepler. Let me make this clear. Kepler's contribution to physical astronomy was to formulate laws which no heavenly body actually obeys, but which enabled Newton to deduce the law of gravitation. The first great step in the development of any physical science is to substitute for the indescribably complex reality of nature an ideal system that is an effective equivalent for the purposes of theoretical computation. I can not refrain from quoting again from Plato's 'Republic' a passage which I have quoted elsewhere. It expresses paradoxically but still clearly the relation of natural philosophy to natural science. In the discussion of the proper means of studying sciences Socrates is made to say: 'We shall pursue astronomy with the help of problems just as we pursue geometry: but we shall let the heavenly bodies alone if it is our design to become really acquainted with astronomy.' What I take to be the same idea is expressed in other words by Rayleigh in the introduction to his 'Sound.' He there points out as an example that the natural problem of a sounding tuning-fork really comprises the motion of the fork, the air and the vibrating parts of the ear; and the first step in sound is to simplify the complex system of nature by assuming that the vibrations of the fork, the air and the ear can be treated independently. Frequently this step is a most difficult one to take. What student of nature, contemplating the infinity of heavenly bodies and unfamiliar with this method of idealism, would imagine that the most remarkable and universal generalization in physical science was arrived at by reducing the dynamics of the universe to the problem of three bodies? When we look round the sciences each has its own peculiar ideals and its own physical quantities: astronomy has its orbits and its momentum, sound its longitudinal vibration, light its transverse vibration, heat its energy and entropy, electricity its 'quantity' and its wave, but meteorology has not yet found a satisfactory ideal problem to substitute for the complexity of nature. I wish to consider the aspect of the science from this point of view and to recall some of the attempts made to arrive at a satisfactory modification of reality. I do not wish to refer to such special applications of physical reasoning as may be involved in the formation of cloud, the thermodynamics of a mixture of air and water vapor, the explanation of optical or electrical phenomena, nor even Helmholtz's application of the theory of gravitational waves to superposed layers of air of different density. These require only conventions which belong already to physics, and though they may furnish suggestions, they do not themselves constitute a general meteorological theory.

The most direct efforts to create a general theory of atmospheric circulation are those which attempt to apply Newtonian dynamics, with its more recent developments on the lines of hydrodynamics and thermodynamics. Attempts have been made, mathematical or otherwise, to determine the general circulation of the atmosphere by the application of some form of calculation, assuming only the sun and a rotating earth, with an atmosphere, as the data of the problem. I confess that these attempts, interesting and ingenious as they are, seem to me to be somewhat premature. The 'problem' is not sufficiently formulated. When Newton set to work to connect the motions of the heavenly bodies with their causes, he knew what the motions of the heavenly bodies were. Mathematics is an excellent engine for explaining and confirming what you know. It is very rarely a substitute for observation, and before we

rely upon it for telling us what the nature of the general circulation of the atmosphere really is, it would be desirable to find out by observation or experiment what dynamical and elastic properties must be attributed to an extremely thin sheet of compressible fluid rotating about an axis with a velocity reaching 1,000 miles an hour, and subject to periodic heating and cooling of a very complicated character. It would be more in consonance with the practice of other sciences to find out by observation what the general circulation is before using mathematics to explain it. What strikes one most about the mathematical treatises on the general circulation of the atmosphere is that what is true about the conclusions is what was previously known from observation. It is, I think, clear that that method has not given us the working ideal upon which to base our theory.

Consider next the attempts to regard atmospheric phenomena as periodic. Let me include with this the correlation of groups of atmospheric phenomena with each other or with those of the sun, when the periodicity is not necessarily regular, and the scientific process consists in identifying corresponding changes. This method has given some remarkable results by the comparison of the sequence of changes in the meteorological elements in the hands of Pettersen and Meinardus, and by the comparison of the variation of pressure in different parts of the globe by Sir Norman Lockyer and Dr. W. J. S. Lockyer; as regards the earth and the sun the subject has reached the stage of productive discussion. As a matter of fact, by continuing this address I am preventing Sir Norman Lockyer from telling you all about it.

For the purpose of dealing with periodicity in any form we substitute for nature an ideal system obtained by using mean values instead of individual values, and leaving out what, from this point of view, are called accidental elements. The simplification is perfectly legitimate. Passing on to the consideration of periodicity in the stricter sense, the process which has been so effective in dealing with tides, the motions of the liquid layer, is very attractive as a means of attacking the problems of the atmosphere, because, in accordance with a principle in dynamics, to every periodic cause there must correspond an effect of the same period, although the relation of the magnitude of the effect to the cause is governed by the approximation of the natural period of the body to that of the cause.

There are two forms of the strict periodic method. One is to examine the generalized observations for periodicities of known length, whether it be that of the lunar rotations or that of sunspot frequency, or of some longer or shorter period. In this connection let me acknowledge a further obligation to Professor Schuster for tacking on to his address of last year a development of his work on the detection of hidden periodicities, by giving us a means of estimating numerically what I may call the reality of the periodicity. The other method is by harmonic analysis of a series of observations, with the view of finding causes for the several harmonic components. I may say that the Meteorological Office, supported by the strong opinion of Lord Kelvin, has favored that plan, and on that account has for many years issued the hourly results for its observatories in the form of five-day means as representing the smallest interval for which the harmonic analysis could be satisfactorily employed. Sir Richard Strachey has given some examples of its application, and the capabilities of the method are by no means exhausted, but as regards the general problem

of dynamic meteorology, harmonic analysis has not as yet led to the disclosure of the required generalization.

I ought to mention here that Professor Karl Pearson, with the assistance of Miss Cave, has been making a most vigorous attempt to estimate the numerical value of the relationship, direct or inverse, between the barometric readings at different places on the earth's surface. The attempt is a most interesting one as an entirely new departure in the direction of reducing the complexity of atmospheric phenomena. If it were possible to find coordinates which showed a satisfactory correlation, it might be possible to reduce the number of independent variables and refer the atmospheric changes to the variations of definite centers of action in a way that has already been approached by Hildebrandsson from the meteorological side.

Years ago, when Buys Ballot laid down as a first law of atmospheric motion that the direction of the wind was transverse to the barometric gradient and the force largely dependent upon the gradient, and when the examination of synchronous charts showed that the motion of air could be classified into cyclonic and anticyclonic rotation, it appeared that the meteorological Kepler was at hand, and the first step towards the identification of a working meteorological unit had been taken—the phenomena of weather might be accounted for by the motion and action of the cyclonic depression, the position of the ascending current, the barometric minimum. The individual readings over the area of the depression could be represented by a single symbol. By attributing certain weather conditions to certain parts of the cyclonic area and supposing that the depression traveled with more or less unchanged characteristics, the vagaries of weather changes can be accounted for. For thirty years or more the depression has been closely watched and thousands of successful forecasts have been based upon a knowledge of its habits. But unfortunately the traveling depression can not be said to preserve its identity in any sense to which quantitative reasoning can be applied. As long as we confine ourselves to a comparatively small region of the earth's surface the traveling depression is a real entity, but when we widen our area it is subject to such variations of path, of speed, of intensity and of area that its use as a meteorological unit is seriously impaired, and when we attempt to trace it to its source or follow it to its end it eludes us. Its origin, its behavior and its end are almost as capricious as the weather itself.

Nor if we examine other cases in which a veritable entity is transmitted can we expect that the simple barometric distribution should be free from inexplicable variations. We are familiar with ordinary motion, or, as I will call it, astronomical motion, wave motion and vortex motion. Astronomical motion is the motion of matter, wave motion the motion of energy, vortex motion the motion of matter with energy, but the motion of a depression is merely the transmission of the locus of transformation of energy; neither the matter nor the energy need accompany the depression in its motion. If other kinds of motion are subject to the laws of conservation of matter and conservation of energy, the motion of the depression must have regard also to the law of dissipation of energy. An atmospheric disturbance, with the production of rainfall and other thermal phenomena, must comply in some way with the condition of maximum entropy, and we can not expect to account for its behavior until we can have proper regard to the variations of entropy. But the conditions are not yet in a form suitable for mathematical calculation, and we have no simple rules

to guide us. So far as meteorology is concerned, Willard Gibbs unfortunately left his work unfinished.

When the cyclonic depression was reluctantly recognized as too unstable a creature to carry the structure of a general theory, Mr. Galton's anticyclones, the areas of high pressure and descending currents, claimed consideration as being more permanent. Professor Köppen and Dr. van Bebber have watched their behavior with the utmost assiduity and sought to find therein a unit by which the atmospheric changes can be classified; but I am afraid that even Dr. van Bebber must allow that his success is statistical and not dynamical. 'High pressures' follow laws on the average, and the quantity we seek is not an average, but an individual.

The question arises, whether the knowledge of the sequence of weather changes must elude us altogether, or will yield to further search. Is the man in the street right, after all? But consider how limited our real knowledge of the facts of atmospheric phenomena really is. It may very well be that observations on the surface will never tell us enough to establish a meteorological entity that will be subject to mathematical treatment; it may be that we can only acquire a knowledge of the general circulation of the atmosphere by the study of the upper air, and must wait until Professor Hergesell has carried his international organization so far that we can form some working idea therefrom of general meteorological processes. But let us consider whether we have even attempted for surface meteorology what the patience of astronomers from Copernicus to Kepler did for astronomy.

Do we yet fully comprehend the kinematics of the traveling depression; and if not, are we in a satisfactory position for dealing with its dynamics? I have lately examined minutely the kinematics of a traveling storm, and the results have certainly surprised me and have made it clear that the traveling depressions are not all of one kinematical type. We are at present hampered by the want of really satisfactory self-recording instruments. I have sometimes thought of appealing to my friends the professors of physics who have laboratories where the reading of the barometer to the thousandth of an inch belongs to the work of the 'elementary class,' and of asking them to arrange for an occasional orgy of simultaneous readings of the barometer all over the country, with corresponding weather observations for twenty-four consecutive hours, so that we might really know the relation between pressure, rainfall and temperature of the traveling depressions; but I fear the area covered would even then hardly be large enough, and we must improve our self-recording instruments.

Then, again, have we arrived at the extremity of our knowledge of the surface circulation of the atmosphere? We know a great deal about the average monthly distribution, but we know litfle about the instantaneous distribution. It may be that by taking averages we are hiding the very points which we want to disclose.

Let me remind you again that the thickness of the atmosphere in proportion to the earth's surface is not unsatisfactorily represented by a sheet of paper. Now it is obvious that currents of air in such a thin layer must react upon each other horizontally, and, therefore, we can not *a priori* regard one part of the area of the earth's surface as meteorologically independent of any other part. We have daily synoptic charts for various small parts of the globe, and the Weather Bureau extended these over the northern hemisphere for the years 1875 to 1879; but who can say that the

meteorology of the northern hemisphere is independent of that of the southern? To settle that primary question we want a synchronous chart for the globe. As long as we are unable to watch the changes in the globe we are to a certain extent groping in the dark. A great part of the world is already mapped every day, and the time has now arrived when it is worth while to consider what contributions we can make towards identifying the distribution of pressure over the globe. We may idealize a little by disregarding the local peculiarities without sacrificing the general application. I have put in the exhibition a series of maps showing what approximation can be made to an isochronous chart of the globe without special effort. We are gradually extending the possibility of acquiring a knowledge of the facts in that as in other directions. With a little enterprise a serviceable map could be compiled; and when that has been reached, and when we have added to that what the clouds can tell us, and when the work of the aeronautical committee has so far progressed that we can connect the motion of the upper atmosphere with the conditions at the surface, when we know the real kinematics of the vertical and horizontal motion of the various parts of a traveling storm, we shall, if the universities will help us, be able to give some rational explanation of these periodic relations which our solar physics friends are identifying for us, and to classify our phenomena in a way that the inheritors of Kepler's achievements associated with us in this section may be not unwilling to recognize as scientific.

W. N. SHAW.

SCIENTIFIC BOOKS.

Introduction to the Rarer Elements. By PHILIP E. BROWNING, Ph.D., Assistant Professor of Chemistry, Yale University. New York, John Wiley & Sons. Pp. viii + 157.

"This small volume, prepared from material used by the author in a short lecture course given at Yale University, is intended to serve as a convenient hand-book in the introductory study of the rarer elements; that is, of those elements which are not always taken up in a general course in chemistry. No attempt has been made to treat any part of the subject exhaustively, but enough references have been given to furnish a point of departure for the student who wishes to investigate for himself. Experimental work has been included except in the case of those elements which are unavailable, either because of their scarcity or because of the difficulty of isolating them."

The above excerpt is taken from the preface of this excellent work. The unusual interest in the so-called rare earths in very recent years has been marked. Doubtless many instructors have wished for a guide to be placed in the hands of students. To be sure, those who have been engaged with investigations along these lines have had at hand Truchot's 'Les Terres Rares,' Herzfeld and Korn's 'Chemie der seltenen Erden' (upon which this book is in a measure founded), as well as such specialized brochures as Koppel's 'Die Chemie des Thoriums,' Giesel's 'Ueber radioaktive Substanzen' and Karl Hofmann's 'Die Radioaktiven Stoffe nach dem gegenwärtigen Stande der Wissenschaftlichen Erkenntnis.' Crookes' 'Select Methods' is classic, but not up to date. Recently the first book on the 'rare earths' published in America came from the pen of Dr. Ohley, but we are not reviewing that work. One almost wonders why such a book as the one under discussion has not been offered before. It comes at a ripe period and well qualified it is to meet a want.

The book is exactly what it pretends to be. The different elements are not taken up in the order of the periodic classification, but each one is treated in a systematic manner; a short history of the discovery, occurrence (with names of the minerals and their accepted formulas, with the average percentage of the particular earth indicated), its extraction, preparation, properties, followed by a

list of the typical compounds known, their characteristics, estimation, separation and finally valuable experimental work for laboratory practise. Numerous references to original papers are given.

To round the work off, consideration is given to platinum and gold, which are without doubt rare metals in some laboratories. Some five pages are allotted to the newly discovered gases in the atmosphere, wherein the fact, not generally known, that Cavendish in 1785 found argon, is alluded to. The last few pages are given to an enumeration of some of the unconfirmed discoveries of new elements within recent times, in fact since 1896. Radium and polonium are disposed of in one paragraph.

There is an index and no advertisements are in the back, for which thanks are due the publishers, who made the book of good appearance.

While in such an abbreviated work the author was confined to well-defined and verified observations, perhaps it might have added value to mention incidentally those uses to which some of the rarer substances are put.

The reviewer is doubtless not familiar with the classification of the author, who places thorium and zirconium in the aluminium group. By analogy according to the oxides, hydroxides and salts, these elements would come in the silicon-titanium group. In the preparation of lanthanum, didymium, etc., no mention is made of the recent elegant electrical methods of Muthmann. In the list of minerals bearing thorium, auerlite is not mentioned. The book does not pretend to contain it all, however.

Every one does not specialize in rare earth chemistry, but the reviewer can not well understand how a teacher of inorganic chemistry can be without some work on the subject. These substances constitute as integral a part of that subdivision of science as any of the other elements.

From the numerous requests for assistance and advice as to literature on the subject, made the reviewer from technical laboratories, it may be well to say that many would do well to have a copy of this book close by. The book is to be commended as fulfilling in a most satisfactory manner what it pretends.

CHAS. BASKERVILLE.

Lehrbuch der kosmischen Physik. II., Physik der Atmosphäre. Von DR. SVANTE AUGUST ARRHENIUS. Leipzig, S. Hirzel. 1903. 8vo. Pp. viii + 553; 138 figs. and charts.

The author of the 'Lehrbuch der kosmischen Physik,' Dr. Svante August Arrhenius, who is professor of physics at the high school in Stockholm, is already known to meteorologists, chiefly through his researches on the effect of the earth's atmosphere upon solar radiation, and on the relation of the moon's declination to atmospheric electricity and magnetism. The 'Lehrbuch' embraces over 1,000 pages all told, of which between 500 and 600 deal with the physics of the atmosphere. With this second portion of the book this review is alone concerned.

Any one who reads these chapters on the atmosphere with the idea that he will find in them a general account of meteorological phenomena such as is to be had in most of the text-books on meteorology will be disappointed. The author makes no attempt to discuss his subject from such a point of view. He expressly states in his preface that he has tried to avoid matters which are purely astronomical, geological or meteorological, and that he has, so far as possible, discussed only such problems as have close relations with physics and chemistry. We have, therefore, in this 'Lehrbuch' no text-book or reference book on general meteorology, but a discussion of the more directly physical relations of the subject. From this standpoint Dr. Arrhenius has given us an excellent piece of work. It is a compact summary of the most important recent investigations of the physics of the atmosphere, and as such it will prove useful to working meteorologists and physicists. The text, however, contains many mathematical formulæ and numerical data and, therefore, makes decidedly 'heavy' reading. The consideration of the measurement of solar radiation is particularly extended. The chapter on

clouds (VIII.) may be taken as a good example of the difference between the present work and the usual text-book of meteorology, and yet this very chapter is more 'popular' than many in the same book. The principal cloud forms are illustrated by means of one unsatisfactory woodcut on page 642. Indeed, the illustrations are comparatively few in number, considering the size of the book. Regarding the origin of cyclones, Arrhenius says (p. 725) that since we know nothing of the vertical temperature distribution in tropical cyclones there is no argument from that standpoint against the convectional theory, as there is in the case of the extra-tropical, 'which are usually cooler at their centers than in the surrounding air.' It has been found necessary to abandon Ferrel's theory for extra-tropical cyclones, although 'it contains a great deal which fits the conditions in the case.' The Hann theory is quoted from Hann's 'Lehrbuch,' and on page 757, after referring to the investigations of Mr. H. H. Clayton on the cyclones of the United States, the author adds that, in the light of the facts now available, 'these cyclones are to be considered as belonging to an earlier stage of development than the European cyclones.' Besides referring to Mr. Clayton's work on cyclones, reference is also made to the Blue Hill kite and cloud investigations and to the results of the studies on New England thunder-storms, carried on some years ago by the New England Meteorological Society. The results obtained in the recent attempts to prevent hail-storms by means of 'weather shooting' are stated (page 805) to be very doubtful. Chapter XIV. concerns 'Meteorological Acoustics,' which is a new heading in a book on meteorology. Chapter XV. (60 pp.) is an extended discussion of 'Meteorological Optics,' a subject which is receiving much attention in Europe. Chapters XVII. and XVIII. (109 pages) treat at some length the subjects of 'Atmospheric Electricity,' and 'Auroras and Terrestrial Magnetism.'

R. DEC. W.

SCIENTIFIC JOURNALS AND ARTICLES.

The Journal of Physical Chemistry, No. 6, June. 'Adherence of Electrolytic Metal Deposits,' by C. F. Burgess and Carl Hambuechen. A paper calling attention to some of the problems of electro-plating, which should be attacked from a scientific standpoint. 'Chemical, Potential and Electromotive Force,' by Wilder D. Bancroft. A development of the work of Gibbs. 'Electrochemical Analysis and the Voltaic Series,' by J. E. Root. An experimental investigation of the relations between voltage and current in different solutions of the metals which may be determined electrolytically. From these is deduced the voltaic series in each solution used, at the temperatures of 20° and 60°. The theoretical possibilities of separation of the different metals electrolytically is discussed. No. 7, October. 'Electrolytic Copper Refining,' by F. J. Schwab and I. Baum. An interesting piece of experimental work designed to determine the best conditions of current density, temperature, etc., for the economical refining of copper. 'The Composition of the Surface Layers of Aqueous Amyl Alcohol,' by Clara C. Benson. The foam of a solution of amyl alcohol is found to be slightly more concentrated than the solution from which it is derived. The solution strength was determined by a viscosity method, depending upon an ingenious apparatus for the uniform production of drops. 'A Correction,' by Geo. H. Burrows.

The Popular Science Monthly for October opens with a paper by Franz Boas on 'The Decorative Art of the North American Indian,' which is largely devoted to showing that the idea now expressed by a given design may be something that was not intended at the outset. In 'Highways and Byways of Animal Life' Herbert F. Osborn discusses some of the peculiar adaptations of animals and the causes which have led to them. Frederick Adams Woods presents arguments and figures to show 'The Correlation Between Mental and Moral Qualities,' and under the title 'Co-operation, Coercion, Competition' Lindley M. Keasbey considers the three characteristic

systems of industrial organization. Robert E. Moritz treats of 'The Sherman Principle in Rhetoric and its Restrictions,' and Elizabeth M. Howe of 'Educational Endowments in the South,' showing how small they are, the reasons for this condition and some of the educationad needs of the southern states. J. A. Fleming presents the fifth of his series of papers on 'Hertzian Wave Wireless Telegraphy.' The number contains the index to Volume LXIII.

The American Naturalist for August contains the second paper by A. W. Grabau on 'Studies of the Gastropoda' and is devoted to *Fulgur* and *Syncotypus,* comprising an account of their development, the succession of their species in time and genetic affinities. Arthur D. Howard has a paper 'On the Structure of the Outer Segments of the Rods in the Retina of Vertebrates' and Edwin W. Doran discusses the 'Vernacular Names of Animals' and propounds a set of rules for the systematic writing of compound names.

A MONTHLY *Journal de chimie et physique* has been started at Geneva under the editorship of Professor P. A. Guye.

DISCUSSION AND CORRESPONDENCE.

THE FIFTH SATELLITE OF JUPITER.

TO THE EDITOR OF SCIENCE: Will you permit me to call attention to a misstatement in SCIENCE, on page 376, second column, undoubtedly unintentional, and at the same time easy of correction. The observations of the fifth satellite of Jupiter, made in the Department of Astronomy and Astrophysics of the University of Chicago, during the past five years, are stated to have been the only ones obtained during that period. As exceptions to this record, measures of the fifth satellite have been made by Doctor Aitken, at this Observatory, in 1898, published in A. J. No. 436; and in 1900 and 1902, published in L. O. Bull. 28; and a series in 1903, not yet published. Such an oversight can easily occur in making up an extensive report, and the credit of the excellent work done at the Yerkes Observatory is in no way diminished by the full statement of the facts.

R. H. TUCKER.

LICK OBSERVATORY,
UNIVERSITY OF CALIFORNIA.

I owe an apology to Professor Aitken for the remark regarding Jupiter's fifth satellite in President Harper's report. When, at President Harper's request, I prepared the statement on the research work of the department of Astronomy and Astrophysics, I understood that the satellite had not been observed elsewhere. There was of course no intention on my part to omit mention of the important work of Professor Aitken with the great telescope of the Lick Observatory.

GEORGE E. HALE.

INVESTIGATIONS IN PROGRESS AT THE UNIVERSITY OF CHICAGO.

THE article in your issue of September 18, under the above title, exhibits an attitude altogether too prevalent among those in authority in this country, and I think justly deserves criticism. It seems to be assumed that if a lot of investigations with high-sounding titles are being carried on at Chicago University, that institution is correspondingly great as a center of research; and that it is a matter of comparative indifference who is doing the work. "I think it best under all the circumstances not to mention in this statement the specific names of persons thus engaged. In most cases, however, the mention of the subject itself will carry with it a knowledge of the person engaged in the work." So it will, to those who happen to know, and to whom the statement is unnecessary.

There are plenty of 'researches' reported in SCIENCE and elsewhere, which are mere air-bubbles, containing nothing. We know very well that most of the work done at the University of Chicago is by no means of this character; that the university is, indeed, a great research center, an ever-flowing fountain of knowledge. But this is due to the *men* who are there, and to describe the work without mention of the workers is as though some theatrical company were to proudly an-

nounce 'we produce all the plays of Shakespeare,' wholly omitting to mention the names of the actors!

Within the last few days I have learned that Mr. Geo. B. King, janitor of the courthouse at Lawrence, Mass., for seventeen years, has been reduced to the position of assistant janitor. Over him has been put a political favorite. Mr. King is poorly educated, and is surrounded by persons who do not believe in scientific janitors; yet he has been able to discover many new Coccidæ in Massachusetts, and his writings on this group are known to entomologists all over the world. Thus does the *man* come to the front, though everything is against him. Yet it is not always so, and for every one having inborn talent who succeeds, no doubt many fail. Mr. King will have to give up all his work in science, if the new conditions are not altered.

It is to the credit and glory of our universities that they can help men to success; can give the conditions which make success in science possible and easy—*given the men.* But after all, the men are everything.

T. D. A. COCKERELL.

COLORADO SPRINGS, COLORADO.

ARCTIC NOMENCLATURE.

TO THE EDITOR OF SCIENCE: The president of the Royal Geographical Society, Sir Clements R. Markham, in the *Geographical Journal* for July, 1903, Vol. XXII., page 7, note, says: "The land which is divided from Greenland by Smith Sound forms a long island, and as many as seven names have been given to various parts of it—1. North Lincoln, 2. Ellesmere Land, 3. King Oscar Land, 4. Schley Land, 5. Arthur Land, 6. Grinnell Land, 7. Grant Land. It is a geographical necessity that, for purposes of description, there should be a name for the whole island. It was first discovered by Baffin in 1616, and first named Ellesmere by Inglefield in 1853. Its name should, therefore, be Ellesmere Island." A map on page 57 of the same volume shows 'Ellesmere Island' and omits 'Grinnell Land' and 'Grant Land.'

It seems desirable to call the attention of American scientists and geographers to this curious proposition, which, without the slightest notice to American geographers, eliminates the American names given to the most important discoveries by Americans in the Arctic, and minimizes as much as possible any recognition of the work of Kane, Hayes, Hall, Greely and Peary.

EDWIN SWIFT BALCH.

PHILADELPHIA,
October 6, 1903.

GONIONEMUS VERSUS 'GONIONEMA.'

DR. MURBACH (SCIENCE, September 18, 1903, 373) has forgotten to add to his letter the following—*Moral:* when proposing a new name give its derivation. F. A. B.

SHORTER ARTICLES.

NEW HORTICULTURAL AND AGRICULTURAL TERMS.

THE extension of horticultural and agricultural knowledge and the extensive literature that is appearing on such topics render it necessary that new words and expressions be coined in many places to give more exact expression to our thoughts. The writer is very much opposed to the wholesale introduction of new terms, as they seldom find use outside of an individual writer's papers. In some cases, however, it is absolutely necessary. Terms for scientific usage are ordinarily derived from Greek or Latin and are seldom fitted for the general use of the masses of the people. Words that we expect to be generally used, the writer believes, should, regardless of derivation, be short, euphonious, phonetically spelled, easily pronounced and different from any other word in ordinary use, so that it will not suggest any other meaning than the one desired. If no word fulfilling these requirements and having the proper signification can be derived from classical sources, the writer strongly favors the policy of inventing a short and convenient term with no meaning other than that given it and without reference to derivation classical or otherwise. By using this policy, short euphonious terms can be secured. Why concede to the Greeks and Latins the sole right of coining words and burden ourselves with inadequate, poorly-

suited, classical or foreign terms when much simpler and better terms could easily be formed with half the effort, if we could be freed from the shackles of philology and feel free to make meaningless terms without a pedigree!

The above sentences are thrown in simply to relieve the writer's feelings. For over two years he has been searching for, and asking friends to suggest, a suitable term to apply to those plants that are propagated vegetatively by buds, grafts, cuttings, suckers, runners, slips, bulbs, tubers, etc. The plants grown from such vegetative parts are not individuals in the ordinary sense, but are simply transplanted parts of the same individual, and in heredity and in all biological and physiological senses such plants are the same individual. The word variety is a generic term which may be used to refer to the races of peas, beans, corn, wheat, etc.; to the strains of these or other plants; and to natural varieties of scientific botanists as well as to those sorts where parts of the same individual are separated and grown; but for special reference to the class of plants propagated by relative parts it becomes very necessary to have a particular designation.

Last year the writer suggested the word *strace* to use for such varieties and the term was referred to a committee of the Association of Agricultural Colleges and Experiment Stations for consideration. The term *strace* is a combination of the words 'strain' and 'race,' already in use. Recently Mr. O. F. Cook, of the Department of Agriculture, has called the writer's attention to the Greek word *clon* (κλών) meaning a twig, spray, or slip, such as is broken off for propagation, which could be used in the connection desired. After careful consideration the writer believes this word much better suited to the purpose than the word strace which he previously suggested. The Greek words *clados* (κλαδος) and *clema* (κλημα) have practically the same meaning and could be used, but are hardly as suitable. *Clados*, shortened to *clad*, becomes a frequently used English term. *Clema* is one letter longer than *clon*. All in all, the term *clon* seems well adapted to the purpose, and as such a word is urgently demanded for general use the writer would suggest its general adoption.

We have then the generic term *variety*, including groups in cultivation known as *races*, *strains* and *clons*.

Variety { Races, Strains, Clons.

Races in a strict sense are those groups of cultivated plants which have well-marked, differentiating characters, and which propagate themselves true to seed except for slight individual variations.

Strains are groups of cultivated plants derived from races from which they do not differ in visible, taxonomic characters in the ordinary sense, but into which has been bred some intrinsic quality such as a tendency to yield heavily, or a better adaptability to a certain environment. When, for instance, a breeder, by the careful selection of Blue Stem wheat produces a sort of Blue Stem which differs from the original race only in its ability to give greater yields, it would be called a strain of Blue Stem wheat. If, however, he selects Jones Winter Fife and changes it from a velvet chaff to a glabrous chaff, he has produced a new race. It must be admitted that there is no very definite line of demarcation between strains and races.

Added to the above two divisions of varieties we should now have:

Clons, which are groups of plants that are propagated by the use of any form of vegetative parts such as bulbs, tubers, cuttings, grafts, buds, etc., and which are simply parts of the same individual seedling. We could then use such expressions as the following: 'The *clons* of apples, pears, strawberries, etc., are not propagated true to seed, while this is one of the important characters of races of wheat and corn,' and 'The differentiating *clonal* characters of chrysanthemums are mainly in the form and color of the flowers.'

Clon, plural *clons* (pronounced with long o), is a short word, easily pronounced, spelled phonetically and with a derivation which at least suggests its meaning. The writer would

urge it as a suitable term to adopt into general usage.

A second term or expression, to which the writer desires to call attention, is the phrase *transmitting power,* to apply to the faculty which an individual organism has of transmitting its individual peculiarities to its progeny. This expression the writer has used in his papers for several years past,* but is not aware that it has been used in this connection by other writers, although it may have been, as it is an expression that would naturally suggest itself to any one thinking on this subject. *Prepotency* has been generally used in this sense, but this word has three well-recognized different meanings, namely,

1. The faculty which an individual has of transmitting its individual qualities to its progeny without variation or reversion, meaning in this case the strength of its hereditary power.

2. The faculty which one species has of dominating another, with which it is crossed, in transmitting its characters.

3. The faculty which one kind of pollen sometimes possesses in being more potent in producing fecundation and offspring than another.

The first of these meanings is that for which the writer uses the expression *transmitting power.* Professor Hays, of the University of Minnesota, uses the expression (*centgener*) power in a similar manner, but this expression seems hardly applicable for use in any case other than where breeding is being conducted according to the centgener system used by him.

In pedigree and grade breeding the transmitting power of the individual is the factor of prime importance that must be discovered by carefully following the performance of each individual in its progeny.

HERBERT J. WEBBER.

PLANT BREEDING LABORATORY,
DEPARTMENT OF AGRICULTURE.

A NEW SPHEROIDAL GRANITE.

GRANITES and diorites, among the deep seated rocks, occasionally develop spheroidal or orbicular structures which are objects of considerable interest to petrographers, and which are exceptional and striking anomalies among the results of crystallization from fusion. Viewed merely as curiosities they would be of only moderate importance, but furnishing, as they do, an illustration of the order in which rock-making minerals separate from the molten magma and gather in aggregates of regular structure, they are the more worthy of attention. The best known of them have been met in Europe, notably at Fonni in Sardinia; Wirvik, Finland; Slätmossa in Sweden; and especially from Corsica, whose beautiful, spheroidal diorite has found a place in all the larger geological museums of the world. In America they are, if anything, less common. One granite, however, has been met in a boulder at Quonochontogue Beach, near Westerly, R. I., which compares favorably in perfection with those of Europe. A less perfect diorite has also been described from Rattlesnake Bar, El Dorado Co., California.

Last spring the writer came into possession of specimens of an exceedingly striking spheroidal rock, which had been discovered in a glacial boulder, by Mr. Horatio P. Parmelee, near Charlevoix, Mich., a town on Lake Michigan in the northwestern portion of the Lower Peninsula. The boulder was several feet in diameter and the largest piece in the possession of the writer is about fifteen inches wide by twenty inches long by eight inches thick. Through the middle runs a pegmatite vein five inches broad, but consisting of the same minerals as those in the spheroids. In fact, several of the spheroids pass imperceptibly into the pegmatite, their outer halves being normal and well-marked and their inner portions passing gradually into the latter.

The distinct spheroids are two to three inches across, and are usually ellipsoidal in shape, although nearly perfect spheres are not lacking. As is the general experience with these rocks the flattened ellipsoids suggest compression due either to flowing movements while the rock was yet plastic or else to dynamic crushes subsequent to consolidation,

* Yearbook, U. S. Department of Agriculture, 1902, p. 369.

the latter being from other evidence less probable.

The spheroids are a brilliant white in color and resemble albite alone, but the microscopic examination reveals considerable orthoclase in addition to the plagioclase, and also much quartz. The quartz fills interstices between the feldspars. The extinction of the plagioclase upon flakes parallel with the basal pinacoid is so slight that the species is in large part oligoclase, but the thin sections give ground for believing albite also to be present and possibly varieties even more basic than oligoclase. The reflections which are given by some broken nodules show that in instances much the greater portion consists of a single feldspar crystal. Others have but few, relatively large individuals; and still others are radiating aggregates. Where the constituent feldspars are coarse and few the core is marked by a few flakes of black biotite irregularly disseminated. They then cease and the main mass of the nodule is feldspar. Even the core may itself practically fail, the nodule becoming a mere ellipsoid of feldspar.

Where the core is well developed it is due to a considerable richness either of biotite or hornblende, both having been observed, but each in different spheroids. They may, however, and probably do occur together. Well-marked rings of biotite or hornblende may also appear half way or two thirds the way from the center to the circumference.

There is no marked outer border to the nodules such as appears in other cases, the contrast being due to the fact that the general matrix is a very dark aggregate of biotite, hornblende, the two feldspars and quartz. The dark minerals are in very large amount, so that the brilliant white nodules stand out with great distinctness.

It appears from the relations of the minerals that the dark silicates first crystallized, together with some feldspar and quartz, and formed the cores. Next followed a period of formation of little else than feldspar and quartz, varied occasionally by a slight separation of the dark silicates. Finally the residue, greatly impoverished by the loss of so much of the feldspathic material, crystallized as the dark matrix.

During the crystallization the pegmatitic streak also formed, and along its borders developed in part as half spheroids. It does not appear to be a phenomenon subsequent to the development of the nodules, and is not very sharply delimited from the spheroidal rock.

The home of the boulder lies somewhere to the north, probably in Ontario, but, so far as known to the writer, no similar rocks have yet been recorded in this region. Acknowledgments are due, in closing, to Professor A. W. Grabau, through whose kind offices the material was secured.

J. F. Kemp.
Columbia University.

PRESENT KNOWLEDGE OF THE DISTRIBUTION OF DAIMONELIX.

Daimonelix when first discovered, in 1891, was thought to be confined to the elevated tablelands of central Sioux County, Nebraska. In the meantime its range has been extended and it is now known almost throughout the entire Arikaree formation, a tract probably about five hundred miles in diameter, situated in Nebraska, Kansas, South Dakota, Wyoming and Colorado. The more fibrous forms of *Daimonelix* constitute a character so constant as to justify the name Fibrous Arikaree for the upper half of the formation. The writer has traced these fossils as represented by the fibrous forms as far south as Benkleman, on the Kansas-Nebraska line, as far east as Fullerton and Long Pine, Nebraska; as far north as Eagle Nest Butte and White Clay Butte, in the Sioux Indian Reservation in South Dakota; and as far west as Lusk, Guernsey and Bates Hole, in Wyoming. Well-authenticated reports would include northeastern Colorado, but those places only are mentioned which have been visited personally by the writer. *Daimonelix* proper is much more restricted than are the fibrous forms. However, its range has been extended beyond the highlands of central Sioux County as far west as Lusk, Wyoming, and as far east as Eagle Nest Butte, South Dakota.

This does not change essentially the original limits ascribed to *Daimonelix*, for outside of Sioux County, where they occur in enormous numbers, they are found sparingly.

In its wider distribution this singular fossil is thought to be represented by a specimen found in Peissenberg, Germany, and described by Dr. Ludwig von Ammon, 'Geognostischen Jahresheften,' 1900, under the title Vorkommen von 'Steinschrauben' (*Dæmonhelix*) in der Oligocänen Molasse Oberbayerns.

ERWIN H. BARBOUR.

THE UNIVERSITY OF NEBRASKA,
December, 1902.

CURRENT NOTES ON METEOROLOGY.

RAINFALL OF INDIA.

THE latest volume of the valuable series of 'Indian Meteorological Memoirs' (XIV., fol., Calcutta, 1902) is a compilation of the rainfall data for 457 Indian stations through the year 1900. In Volume III. of the 'Memoirs,' Appendix A, Blanford had previously given the monthly rainfalls for various periods ending with December, 1886. The present publication will for some years be the authority on Indian rainfall statistics. Considerable interest has always attached to the rainfall at Cherra Poonjee (as the spelling is in the report under consideration), in the Khasi Hills, north of the head of the Bay of Bengal, which has held the record for the heaviest annual precipitation. According to the latest average, carried through 1900, the mean annual rainfall at this station is 457.80 inches. A new subdivision into the northeast monsoon and the southwest monsoon rainfalls, coming respectively in December–April and May–November, will be found useful by students of special problems in connection with the climatology of India.

TORNADO AT GAINESVILLE, GA., JUNE 1, 1903.

IN an account of the Gainesville tornado of June 1 last, published in the *Monthly Weather Review* for June, mention is made of two facts which show clearly the effect of the sudden expansion of the air in enclosed spaces. In one case the walls of a mill 'fell outward, and the roof was lifted into the air and held suspended for several seconds.' The other concerned a standpipe, fifty feet off the ground, and about fifty feet high. This standpipe was about forty feet in diameter, and covered with a sheet-iron cupola. The latter, 'weighing several tons, was lifted bodily from the top of the standpipe, carried high into the air, and dropped about a hundred feet in front of the mill, killing several persons who had thus far escaped danger.'

WEATHER REPORTS FROM VESSELS AT SEA.

IN the same number of the *Review*, Professor A. G. McAdie notes that daily meteorological reports were received at San Francisco from the cable ship *Silvertown*, while this vessel was laying the American trans-Pacific cable. The first report was received when the vessel was 90 miles off shore, and the last when she was about 2,000 miles away. These reports proved of value in making the weather forecasts at San Francisco.

R. DEC. WARD.

THE MOSELEY EDUCATIONAL COMMISSION.

THE members of Mr. Alfred Moseley's commission have arrived in this country to study our educational system. The commission is informal in character, although it includes official delegates from various institutions. It is expected that about two months will be spent in visiting the chief educational centers of the country, attention being paid to the public school system and to higher education. The members of the commission, all of whom, except three who are expected later, have spent the past week in New York City, are as follows:

Arthur Anderson, J.P., Alderman, and Chairman of Technical Instruction Committee of the West Riding County Council. (Nominated by the County Councils Association.)

W. F. Ayrton, F.R.S., professor of physics in the Central Technical College, ex-President Institute of Electrical Engineers.

Thomas Barclay, LL.B., ex-President Paris Chamber of Commerce.

A. W. Black, J.P., mayor of Nottingham; Chairman of the Nottingham Educational Committee.

R. Blair, M.A., B.Sc., assistant secretary for Technical Instruction of the Department of Agricultural and Technical Instruction, Ireland. (Nominated by Department of Agriculture and Technical Instruction.)

J. Rose Bradford, M.D., F.R.C.S., F.R.S., professor of medicine, University College, London.

G. J. Cockburn, ex-Chairman of the Leeds School Board.

The Rt. Reverend, the Bishop of Coventry, ex-Chairman of the Birmingham School Board.

Harry Coward, president of the National Union of Teachers. (Nominated by the National Union of Teachers.)

The Rev. Professor Finlay, S.J., F.R.U.I., member of the Technical Education Board, Ireland; professor of political economy, University College, Dublin. (Nominated as official representative of the Board of Agriculture and Technical Education of Ireland.)

Percy Frankland, Ph.D., B.Sc., F.R.S., professor of chemistry in the University of Birmingham.

T. Gregory Foster, B.A., Ph.D., assistant professor of English in University College, London, and Secretary to the college.

W. C. Fletcher, M.A., late fellow of St. John's College, Cambridge; Head Master of the Liverpool Institute.

W. H. Gaskell, M.A., M.D., F.R.S., fellow of Trinity Hall, Cambridge; university lecturer in physiology.

The Rev. H. B. Gray, D.D. (Oxford), warden of Bradfield College.

W. P. Groser of the Inner Temple, representing the Parliamentary Industry Committee, and to inquire into legal education.

C. J. Hamilton, B.A. (Cambridge), F.S.S., lecturer in political economy, University College, Cardiff; Secretary to the Commission.

J. R. Heape, Chairman of the Rochdale Technical School.

The Rev. A. W. Jephson, M.A., member of the London School Board.

William Jones, M.P. for Arfon Division of Carnarvon, representing the Parliamentary Industry Committee.

Magnus Maclean, M.A., D.Sc., professor of electrical engineering in Glasgow and West of Scotland Technical College, Glasgow. (Nominated official representative by (1) Glasgow and West Scotland Technical College; (2) Edinburgh School Building; (3) the Technical and Secondary Education Committee of the Ayrshire County Council.)

The Rev. T. L. Papillon, M.A., Vicar of Writtle, Essex. Late fellow and tutor of New College, Oxford; formerly fellow of Merton College.

Herbert R. Rathbone, B.A., Barrister-at-law, member of the Education Committee, and Deputy Chairman of the Committee on Elementary Education, Liverpool.

H. R. Reichel, LL.D., late fellow of All Soul's College, Oxford; Principal of University College of North Wales, Bangor, and member of the Welsh Intermediate Education Board. (Nominated as official representative of the University College of Cardiff, Aberystwyth, and Bangor.)

John Rhys, LL.D., professor of Celtic in the University of Oxford; member of the British Academy and of the Oxford Education Committee. Sometime H. M. Instructor of Schools.

W. Ripper, M.I.S.E., professor of engineering in University College, Sheffield. Member of the Sheffield Education Committee.

Charles Rowley, M.A., J.P., member of the Manchester Education Committee and of the Manchester School of Technology, chairman of the Manchester School of Art.

Sir Albert Kaye Rollit, LL.D., D.C.L., M.P., Vice-President of the London Chamber of Commerce. (Nominated by the Association of Municipal Corporations.)

A. J. Shepheard, chairman of the Technical Education Board of the London County Council.

A. Edmund Spencer, B.A. (Oxford), barrister-at-law, director of Plymouth Girls' High School; member of Plymouth Chamber of Commerce, Executive member of Committee of the Mount Edgecombe Industrial Training Ship. Representing Plymouth.

John Whitburn, member of the Education Committee of Newcastle-on-Tyne.

THE ST. LOUIS MEETINGS.

Reference has been made several times in the course of the year in the columns of Science to the scientific meetings to be held in St. Louis in convocation week, beginning on December 28. The American Association for the Advancement of Science and most of the bodies which commonly meet in affiliation

with the association decided last winter to hold their next meeting in St. Louis, and it was expected that, in continuation of the effort that has been made for the last two years, the American Society of Naturalists and most of the bodies of professional men who have met in affiliation with that society would decide to hold their coming meeting at the same place. Unfortunately the American Society did not reach a decision as to its meeting place until autumn, and in the meantime some of the affiliating bodies had decided on an eastern meeting, though the larger number of them are expected to meet in St. Louis, with the Naturalists, at the time of the American Association meeting.

Desiring and anticipating a large attendance, the scientific and educational interests of St. Louis have organized an efficient local committee, and this committee is now at work on arrangements for the meeting. To facilitate these arrangements, it is desirable that the secretaries of the different sections of the American Association, and of all the other bodies that are to meet there in convocation week, write at the earliest possible date to the local secretary, Professor A. S. Langsdorf, of Washington University, St. Louis, letting him know the estimated seating capacity needed for their meetings, as well as the equipment that will be necessary or desirable, so that the subcommittee on equipment may secure ample provision for each.

It is probable that the meetings will be held in the Central High School, with a possible overflow into adjacent suitable buildings, but there is every reason to believe that if the committee is given prompt and definite information on which to make its arrangements all the meetings can be held so close to one another that those desiring to pass from one section to another or from either to the sessions of any affiliated society can do so without loss of time, thus avoiding some of the difficulties of the meetings last winter. The High School is a modern building with interior telephone service and other conveniences; adequate telephone, mail, express and other facilities will be provided and if it is wished a local telegraph office can be established in it; a considerable number of the rooms are provided with lanterns as a part of their regular equipment, and enough others to secure reasonable convenience for sections that only occasionally use this adjunct can be provided; and arrangements are being made to ensure adequate and reasonably cheap hotel accommodations in the vicinity of the High School, which is within easy reach by trolley service of the railroad station and downtown hotels, while the grounds and buildings of the World's Fair, Washington University, the Academy of Science and the Missouri Botanical Garden are all readily reached from this point, which is centrally situated with respect to the extensive trolley service of the city. Every possible courtesy will be extended to those in attendance at the meetings, by the citizens of St. Louis and the exposition authorities, and it is expected that the transportation committee will secure rates that will make it possible for those living at a considerable distance to attend the meetings without serious expense. It is, therefore, to be hoped that the secretaries of the sections of the American Association and of the Society of Naturalists and all of the societies that are to meet in connection with these organizations will work in cooperation with each other to prepare a general program that will possess the greatest possible homogeneity and convenience and that the local committee may promptly be placed in possession of definite data on which they may provide ample accommodations for all.

SCIENTIFIC NOTES AND NEWS.

THE new medical buildings and laboratories of Toronto University, described by Professor A. B. Macallum in a recent issue of SCIENCE, were officially opened on October 1. The opening address was given by Professor Charles S. Sherrington, of Liverpool. Speeches were made by representatives of the various institutions, and an address in the evening was made by Professor William Osler, of the Johns Hopkins University. A special convocation was held on October 2, at which the following distinguished visitors received the honorary degree of LL.D. from the university: William Williams Keen, Jefferson Medical College, Philadelphia; William Henry Welch, Johns Hopkins University; William Osler, Johns Hopkins University; Russell Henry Chittenden, Yale University; Charles S. Sherrington, University of Liverpool; Henry Pickering Bowditch, Harvard University (*in absentia*).

PROFESSOR VON BEHRING, the eminent pathologist, has been made a member of the Russian privy council.

PROFESSOR CHARLES M. BRISTOL, of New York University, returned on October 7 from the Bermuda Islands, where he has had charge of the Biological Station. He spent the last three weeks in making a collection of tropical fishes, which are to be exhibited under the auspices of the U. S. Bureau of Fisheries at its salt-water aquarium in St. Louis during the World's Fair of 1904.

SIR DANIEL MORRIS, British Imperial Commissioner of the Department of Agriculture for the West Indies, and Mr. John R. Rovell, of the Agricultural Department of Barbadoes, are at Charleston, to make a study of the cultivation of cotton.

M. DYBOWSKI, the French inspector of colonial agriculture, has been sent on a mission to study the agricultural conditions in Senegal and French Guinea.

DR. HENRY S. PRITCHETT, president of the Massachusetts Institute of Technology, sailed on October 5 from New York on the steamer *Kronprinz* for Germany. It is expected that he will be absent from Boston for only about four weeks.

MR. W. N. MCMILLAN, of St. Louis, who recently failed in an attempt to explore the course of the Blue Nile, is returning to this country. He expects to start with another expedition in December.

DR. G. S. FRAPS, assistant professor of chemistry at the North Carolina College of Agriculture and Mechanic Arts, and assistant chemist at the North Carolina Experiment Station, has been appointed assistant chemist to the Texas Experiment Station at College Station.

MR. CLARENCE T. JOHNSTON, for several years past assistant in the irrigation investigations of the Department of Agriculture, and in charge of the office at Cheyenne, Wyoming, has resigned to accept the appointment of state irrigation engineer of Wyoming.

MR. CLARENCE B. LANE, assistant in dairy husbandry at the New Jersey station, has been appointed assistant chief of the dairy division of the Agricultural Department. He succeeds Mr. Harry Haywood, who resigned during the summer to assume charge of the newly organized agricultural department at the Mount Herman School, near Northfield, Mass.

THE French government has appointed a commission to study the causes of the disappearance of the sardine. It consists of M. Vaillant, professor at the Museum of Natural History; M. Domergue, inspector general of marine fisheries; and M. Canu, director of the agricultural station at Bologne-sur-Mer.

PROFESSOR FERDINAND HUEPPE, of Prague, is giving this month at King's College, London, the Harben lectures of the Royal Institution of Public Health.

THE Christian A. Herter lecture, at the Johns Hopkins University, the first of the series established by Dr. and Mrs. Herter, of New York City, a year ago, was given by Dr. Herter on October 6, his subject being 'The Work of Pasteur.'

AMONG the lecture courses arranged for the present season by the Brooklyn Institute of Arts and Sciences is a course of six lectures

by Professor Harry C. Jones, of the Johns Hopkins University.

DR. JACQUES LOEB, professor of physiology at the University of California, was expected to lecture at Stanford University on October 13, under the auspices of the Sigma Xi Scientific Society.

PROFESSOR DAVIDSON has been appointed literary executor under the will of the late Professor Bain. He is empowered to edit a volume of remains and a biography, for which ample materials have been left.

A STATUE in honor of the eminent French neurologist M. Charcot has been erected at Lemolon-les-Bains.

MR. CORNELIUS VAN BRUNT, of New York city, well known as a botanist and especially for his beautiful reproductions of flowers, died on October 1 at the age of seventy-six years.

MR. JOHN ALLEN BROWN, the author of numerous contributions to anthropology and geology including a work on paleolithic man in northwest Middlesex, died in London, on September 24, at the age of seventy-two years.

THE deaths are also announced of Dr. Rudolf Lipschitz, professor of mathematics at Bonn, and of M. A. Certes, known for his bacteriological researches and formerly president of the French Zoological Society.

THE statement having been published that the heavy fall in the shares of the U. S. Steel Corporation would adversely affect the value of the gifts bestowed by Mr. Carnegie, that gentleman has telegraphed as follows: "Skibo Castle, N. B.—Mr. Carnegie never owned any second mortgage bonds or shares of the United States Steel Trust. His bonds are first mortgage, covering all the property, and are not quoted upon the Stock Exchange."

ON October 1, the organization of the Wisconsin State Hygienic Laboratory was completed in accordance with the legislative enactment of last winter. The laboratory is located at Madison in connection with the Bacteriological Department of the University of Wisconsin and is expected to cooperate with the State Board of Health in its work. The director of the laboratory is Professor H. L. Russell. Mr. G. J. Marquette has been appointed first assistant. The work of the laboratory will be along the usual lines followed in board of health work.

The American Geologist states that a movement is on foot in the state of Nebraska for the erection at Lincoln of a special building for the use of the Historical Society and the Geological Survey of the state.

THE governing body of the Lister Institute of Preventive Medicine announces that the necessary legal formalities in connection with the change of name of this institute have now been completed, the Board of Trade having sanctioned the new name. The institute will therefore now be known as the 'Lister Institute of Preventive Medicine,' instead of the Jenner Institute of Preventive Medicine. The address, Chelsea-gardens, S.W., remains the same.

IN pursuance of the British Board of Agriculture and Fisheries Act, 1903, the powers and duties of the Board of Trade under the Salmon and Freshwater Fisheries Acts, the Sea Fisheries Regulation Acts and other Acts relating to the industry of fishing have been transferred from that department to the Board of Agriculture, which is to be styled in future the Board of Agriculture and Fisheries. An additional assistant secretary to the Board of Agriculture and Fisheries for fishery business has been provided for, and the Earl of Onslow has appointed to that position Mr. Walter Edward Archer, who has hitherto held the post of chief inspector of fisheries under the Board of Trade.

The American Geologist states that under the auspices of the Civil Commission in charge of the Philippine Islands and immediately under the supervision of Mr. D. C. Worcester, the secretary of the interior of islands, there has been established a mining bureau. This bureau contemplates a thorough investigation into the natural resources of the principal islands, and has already published a finely printed and illustrated bulletin on the iron ores, prepared by Mr. H. D. McCaskey. This mining bureau desires to secure the services

of a good petrographer and an experienced paleontologist. Inquiries may be addressed to Mr. McCaskey at Fort Sheridan, Ill.

There will be a civil service examination on November 11, to fill the position of assistant in soil management, Bureau of Soils, Department of Agriculture, at an annual salary of $1,000 to $1,400 a year.

A meeting was held at Tacoma, Washington, on October 7, to protest against the government's policy of increasing the reserves in the northwest. The meeting was addressed by Mr. Gifford Pinchot, chief of the Bureau of Forestry, who promised that no unnecessary restrictions should be placed on opening the forest reserves to agriculture or to the proper cutting of timber.

The Iowa Anthropological Association has been organized with headquarters at Iowa City. Duren J. H. Ward, Ph.D., is the secretary. An anthropological survey of the state is already under way.

At the last annual meeting of the American Electro-Therapeutic Association, held at Atlantic City, N. J., on September 22, 23 and 24, 1903, the following officers were elected: *President,* Alonso David Rockwell, A.M., M.D., New York, N. Y.; *First Vice-President,* Willis Parsons Spring, A.B., M.D., Minneapolis, Minn.; *Second Vice-President,* William Winslow Eaton, A.M., M.D., Danvers, Mass.; *Treasurer,* Richard Joseph Nunn, M.D., Savannah, Ga.; *Secretary,* Clarence Edward Skinner, M.D., LL.D., New Haven, Conn. The next annual meeting will be held at St. Louis, Mo., on September 13, 14, 15 and 16, 1904.

A society for the study of tropical medicine has been organized at Philadelphia, with Dr. Thomas H. Fenton as president, and Dr. Joseph McFarland as secretary.

An International Sanitary Congress for the Adoption of Means of Defense against Cholera and the Plague opened at Paris on October 10. Representatives of twenty-five powers were present, including Surgeon Anderson, United States Navy, medical inspector of the United States European station; Col. Gorgas, formerly chief sanitary officer of the United States at Havana, and Dr. Giddings, representing the United States.

An International Congress of Ophthalmology will be held at Lucerne, Switzerland, in September, 1904.

At the conclusion of the meeting of the Iron and Steel Institute at Barrow-in-Furness, Mr. Charles Kirchhoff tendered on behalf of the American members of the institute an invitation to hold its next annual meeting in New York. The invitation, which was endorsed by the American Institute of Mining Engineers and other important bodies, was accepted on behalf of the institute by Mr. Andrew Carnegie. It is now proposed that the autumn meeting shall take place in New York on October 24, 25 and 26 next year. After the meeting there will be an excursion to Philadelphia, Washington, Pittsburg, Cleveland, Niagara Falls, Buffalo and the St. Louis Exposition, returning to New York on November 10. The institute had a similar trip in 1890.

An International Congress of School Hygiene will be held at Nuremberg, Germany, on April 4–9, 1904. All persons interested in this subject are eligible to membership, after approval by the local committee. There will be ten sections, as follows: (1) Hygiene of the school building and its appointments. (2) Hygiene of boarding schools. (3) Methods of hygienic research. (4) Hygiene of the mental education. (5) Hygienic instructions for masters and pupils. (6) Bodily training of pupils. (7) Illness, minor ailments, and medical attendance in schools. (8) Children of weak intellect, and schools for their benefit; courses for stutterers, for the blind, deaf and dumb; schools for cripples. (9) Hygiene of the scholars after school hours, holiday camps and organization of evening instruction in school-hygiene for parents. (10) Hygiene of the teachers. The American members of the committee are President Nicholas Murray Butler of Columbia University, Professor W. T. Porter of the Harvard Medical School, and Professor John A. Bergström of the University of Indiana.

THE Marconi Wireless Telegraph Company and Dr. Reginald Fessenden, are defendants in two suits for infringement instituted in the United States Circuit Court at Trenton, N. J., on October 5, by the International Wireless Telegraph Company. The plaintiff claims to have purchased from Professor A. Emerson Dolbear, Tufts College, patents for a system of wireless telegraphy granted on October 5, 1886. Professor Dolbear in an affidavit sets forth that he was the original inventor of the system. He charges that the Marconi Company has been aware of his patent rights and has been repeatedly warned that it was infringing them. The International Company seeks an injunction and damages.

THE Stockholm correspondent of the London *Times* writes that on September 14 the Swedish expedition in the *Frithjof* met the French expedition in the *Français* under Dr. Charcot at Funchal. A letter from a member of the Swedish expedition states that the French ship is very adequately fitted and that the laboratories are extremely well furnished with the best modern instruments. Dr. Charcot has placed himself and his ship at the disposal of Captain Gyldén, who is in charge of the *Frithjof*, and as there is some prospect that the Argentine vessel *Uruguay* may do the same, the relief expedition will be undertaken with three ships in constant communication with each other. Thus there seems every chance of bringing the expedition to a happy and expeditious issue. The *Frithjof* and the *Français* left Funchal together on the evening of September 16 *en route* for Buenos Ayres.

A REUTER telegram from Rio de Janeiro states that the Brazilian chamber has adopted the third reading of the bill to establish an international steerable balloon competition to be held at Rio in 1904, for a prize of 200 contos of reis. The scheme has been submitted to the senate.

ON the recommendation of Rear Admiral Rae, chief of the Bureau of Steam Engineering, the secretary of the navy has appointed a board consisting of Capt. G. A. Converse, Commodore J. A. Perry and Lieutenant Cleland Davis, to report upon the subject of training of line officers of the navy in engineering. In the order constituting the board, the following instructions are given: The board will consider and report upon the subject of engineering instruction and training for officers of the line of the navy involved in the consolidation of the line and Engineering Corps by the Navy Personnel act of Congress of March 2, 1899. The board will report what plan it considers will best qualify officers for the efficient performance of engineering duties. The report will include the recommendations as to: First. The establishment of an engineering school for officers, its character, location, administration and government. In this connection the board will report as to the availability of the engineering experimental station at Annapolis for this purpose. Second. The period in their professional career in which officers should receive this instruction. The report will comprehend all details necessary to a complete understanding of this scheme or any other that the board may propose. The engineering instruction referred to should insure thoroughly efficient care, preservation and management of machinery afloat; but it is directed that the board also report upon the subject of further instruction in engineering for officers who evince a marked aptitude and interest in that branch of the profession and who choose to pursue that study as a specialty. The department desires the board to consider what measures should be adopted in order to insure a sufficient number of officers devoting their attention to engineering and whether the status of such officers shall differ in any respect from that of line officers in general in the corresponding grades.

WE learn from *Nature* that the Great Western Railway Company now offers facilities, in conjunction with the Swindon Education Committee, to their apprentices to enable them to gain technical scientific knowledge. A limited number of selected students may attend day classes at the technical school. They must have spent at least one year in the factory, and must have regularly attended for

at least one session in the preparatory group of evening classes at the technical school. The number of students must be limited to thirty at any one time. For each year's course there will be a competitive examination, successful students passing on from one year's course to the next. The course of study for each year will consist of practical mathematics, practical mechanics, geometrical and machine drawing, heat, electricity and chemistry. Those attending the classes will have their wages paid as if at work in the factory, and the Great Western Railway Company will pay their school fees. The students attending the day classes will be expected to give some time each evening to private study. Students who distinguish themselves will be allowed to spend part of their last year in the drawing office and chemical laboratory. The whole of the arrangements will at all times be under the direction of the chief mechanical engineer.

Dr. Henry M. Leipziger, supervisor of free lectures of the New York City Board of Education, says in his annual report: "The attendance at the scientific lectures is such as to show that the purpose of the lecture course should be to lay especial stress on popularization of science. The great need of our country is an increase in popular technical instruction, and the demand in our land for thoroughly trained workmen is always great. The intelligent workman should be thoroughly equipped in scientific principles, and the lecture course is one medium for giving that general information in scientific subjects which many mechanics lack. For this reason it is hoped that at no distant day two or three well-equipped science halls, where experiments can well be made, will form a feature of the educational plant of the city, and to these halls shall come the very ablest scientists to expound to the thinking people of our city the great principles of science, and elaborate on the great discoveries that are constantly being made. Such lectures will be of inestimable value in improving the intellectual condition of the workingman."

UNIVERSITY AND EDUCATIONAL NEWS.

Ground will be broken shortly at Leland Stanford Junior University for a new library building to be erected at a cost of over $500,000. The building will be given to the university by Mrs. Stanford. It is said that she or Mr. Thomas Welton Stanford may also endow the library without drawing on the permanent funds of the university.

By the will of the late Frederick W. Guiteau, Cornell University receives $100,000 and the residue of the estate, which it is said may amount to a considerable sum.

Mr. J. Ogden Armour, of Chicago, has endowed with $100,000 a chair of orthopedic surgery in St. Joseph's Hospital, Omaha, Nebraska.

An appointment as assistant demonstrator of physiology in the Medical Department of the University of Pennsylvania is open for applications. The appointee will devote his mornings to laboratory teaching, his afternoons to research, and will receive a salary of $500.

Dr. R. E. Hedrick, instructor in mathematics in the Sheffield Scientific School of Yale University, has been called to a chair in the University of Missouri.

Dr. Kenneth L. Mark, son of Professor E. L. Mark of Harvard University, has been appointed instructor in chemistry in Simmons College, Boston.

Dr. D. Hepburn, of the University of Edinburgh, has been appointed to the chair of anatomy in University College, Cardiff, vacant by the removal of Professor A. F. Dixon to Trinity College, Dublin.

At the Heriot-Watt College, Edinburgh, Mr. Roderick M. Shearer, M.A., B.Sc. (Edinburgh), has been appointed chief lecturer in mathematics; Mr. William C. Houston, B.Sc. (Glasgow), to be assistant professor of mechanical engineering; Mr. W. Mansergh Varley, B.A. (Cantab.), Ph.D. (Strasburg), to be assistant professor of physics and electrical engineering; and Dr. Bertram D. Steele, D.Sc. (London), McGill University, to be assistant professor of chemistry.